EFFECT OF COMPOSITIONAL PARAMETER ON MECHANICAL PROPERTIES OF SELF-COMPACTING CONCRETE BASED OF GROUND DUNE SAND

[1]MAKANI A., [2]BENMERIOUL F., [3]ZAOIAI S., [4]TAFRAOUI A.

[1,2,3,4]Université TAHRI Mohamed Béchar, Département de Génie Civil, LFGM (Laboratoire de Fiabilité du Génie Mécanique), BP 417 Béchar (08000), Algeria
E-mail: [1]makaniabdelkadir@yahoo.fr, [2]ahmedtafraoui@yahoo.fr, [3]faridbba37@yahoo.com, [4]zawiamin@yahoo.com

Abstract - The Self-compacting concrete (SCC) are a new family but also a new technological step in the field of Civil Engineering. This new technique has gradually developed in Europe and is now established as a support technique that will eventually replace the conventional technique of concrete vibrated in many applications. However, this development can only be achieved with some support tools as new characterization tests requiring new equipment to job rules adapted to their specificities. The characteristics of the SCC are directly related to their composition, namely cement, aggregates and water. The research work is therefore to carry out a comparison in terms of mechanical performance between different SCC based formulations Ground dune sand (GDS) to find the optimal ratio of water on cement (W/C).
This study showed that the use of GDS, as an addition, in the composition of SCC contributes to a slight variation of the parameters of workability fresh still remaining in the area of SCC required by AFGC recommendations. Thus, the mechanical properties of SCC are inversely proportional with the W/C ratio, the mechanical strengths of SCC increased with the decrease of W/C (interesting values, 55 MPa for the compression W/C = 0 4).
Finally, we can conclude that our results provide evidence mechanical performance for dune sand development prospects in the new concrete, namely the SCC.

Index Terms - Self-Compacting Concrete, Ground Dune Sand, W/C Ratio, Formulation, Mechanical Performance.

I. INTRODUCTION

The Self-Compacting Concretes (SCC) are relatively new concretes, and their application has not yet been generalized in the world of construction, except in certain developed countries, Canada and Japan which is considered the innovator of this new material. They are very fluid concretes whose implementation without vibration has several advantages at the environmental, technological and economic levels which interest more and more industrial [1,2,3].

It is essential that the concrete retains its stability and ensures perfect homogeneity. These two contradictory properties are ensured by the use of the superplasticizer and the incorporation of the mineral additions in their compositions [3, 4,]. In the eighties and nineties, the studies relating to the high performance concretes showed the harmful role of the excess water in concretes. The reduction of this quantity of water, by the use of deflocculants and by the correction of granular stacking via ultrafine, has led to the strength and durability gains that are known [5,6].

As part of the development of sand dune incorporated in the new concrete [7]. The present work aims to understand the influence of water dosing on the behavior of the SCC in the fresh and hardened state and above all to look for solutions to optimize a self-compacting concrete formula based on local materials.

II. BASIC MATERIALS

A. Cement

The cement used is Portland cement Composed CEM II / B resistance real Matine 42.5 MPa (under its trade name).

B. Additions

Crushed dune sand from crushing dune sand coming from the commune of Taghit, wilaya of Bechar (Algeria) (Dmax ≤ 80 μm).
Table 1 present a Physical properties of Portland cement and dune sand.

Table 1: Physical properties of Portland cement and dune sand [7]

Items	Portland Cement	Dune Sand	Regulatory
Absolute density	3.05	2.8	NF P 18-558
specific surface (cm2/g)	3200	3000	EN 196-6
Unit weight (kg/m3)	1120	1300	NF P 18-554

The results of DRX analysis carried out on the dune sand of Taghit and Portland cement are presented graphically on Fig 1. It was noticed a peak of approximately 100 % of silica with dune sand and

calcite for cement which translated the predominance of SiO2 and CaCO3, the others revealed elements present at small percentages.

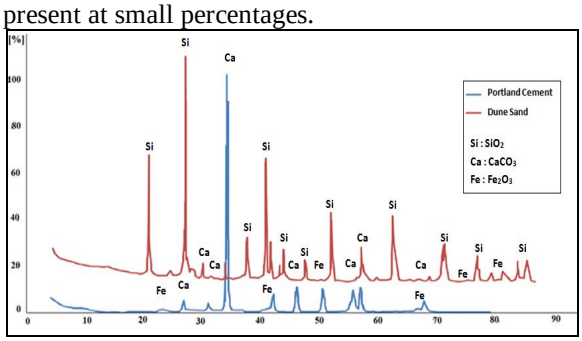
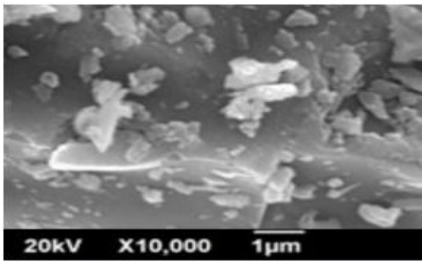


Fig. 1 XRD analyze of Portland cement and dune sand

From the fig 2, it was observed that the shape of Portland cement particle is angular, dappled, broken or round forms observed for dune sand.

(a) Portland cement



(b) Dune sand

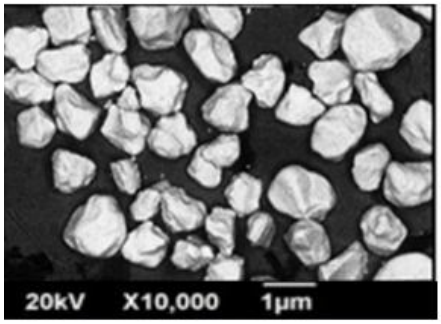


Fig. 2 SEM photographs of additions used [8]

The chemical compositions of Portland cement and dune sand are presented in table 2.

Table 2: Chemical properties of Portland cement and dune sand [9]

Elements (%)	Cement	Dune sand
SiO2	17.49	97.15
Al2O3	4.51	0.79
Fe2O3	3.02	0.21
CaO	62.78	0.11
MgO	2.15	0.05
SO3	2.38	0.14
Na2O	0.05	0.18
TiO2	0.64	0.05
Others	0.02	< 0,02
Loss of ignition	8.10	0.58

C. Aggregates

The aggregates play an important role in the behavior of concrete. Their influence is very strong in terms of mechanical performance.

Rolled sand class (0/3), (3/8), (8/15) comes from the Mahmoudi quarry (Bechar).

Fig. 3 represents the particle size distribution curves of the aggregates used.

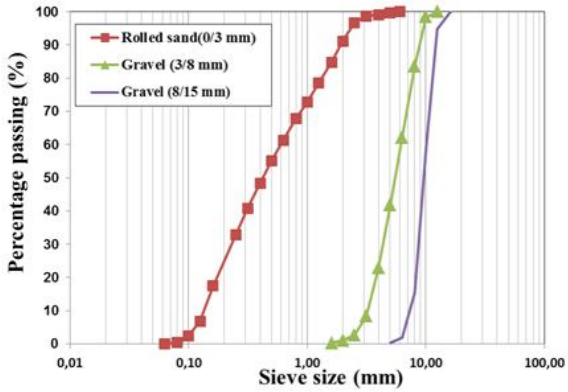


Fig. 3. Particle size distribution curves of the aggregates used

Table 3 represents the physical characteristics of materials.

Table 3: Physical characteristics of materials

	Rolled Sand (0/3)	Gravel (3/8)	Gravel (8/15)
Sand Equivalent (%)	74	—	—
Fineness modulus	2.1	—	—
Absolute volumetric mass (kg/m^3)	2604	2630	2666
Apparent volumetric mass (kg/m^3)	1761	1606	1444

D. Superplasticizer

The superplasticizer used is SIKAPLAST 5045 / High Reducer Water / retarder for concrete ready and compacting concretes were compacted according to NF EN 934 -2 norm.

E. Mixing water

The water abstraction is done on the conduct of drinking water supply of the town of Bechar, from the dam "Djorf Torba", located 60 km west of Bechar. This water is treated for drinking.

III. FORMULATION OF CONCRETE

For this purpose the authors first made a self-compacting-concrete (SCC) based solely on the criteria recommended by AFGC [15] (report (Gravel / Sand) to be close to 1, the volume of paste must be between 330 and 400 l/m3, the cement dosage is between 300 and 350 kg/m3; the dosage of the

superplasticizer must ensure the fluidity of the mixture.) The final formulation of the self-compacting-concrete is given in table 4. Two concretes are thus obtained, one with the limestone filler, named SCC LF, and another with crushed dune sand, named SCC CS.

Table 4: Compositions of Self-Compacting-Concrete (kg/m^3)

	SCC40	SCC45	SCC50	SCC55
W/C	0.40	0.45	0.50	0.55
Cement	416			
Addition	104			
Sand 0/3	903			
Gravel 3/8	151			
Gravel 8/15	578			
Superplasticizer	6.8			

IV. EXPERIMENTAL METHODS

A. Fresh state test

The SCC must satisfy many tests; three were chosen, which are recommended by AFGC that allow to characterize the principal properties of SCC in the fresh state (fluidity, static and dynamic stability, free and confined environment) spreading Abrams cone flow box L and stability through a sieve (Table 5 and fig. 4.).

Table 5: Values recommended for testing AFGC norm, 2008 [10]

	Slump flow	L – box	Stability in sieve (%)
Limit values	60 à 75 cm	≥ 0.8	≤ 15 %

(a) Slump-flow Test



(b) L-box test



(c) Screen Stability test



Fig. 4. Workability tests

B. Compressive strength test

For assessing mechanical compressive strength with NF EN 12390-5 standard [17], the compression test (fig.5) breaks the test specimen between the two plates of a compression press. The press used is the ELE AUTOTEST compression machine.

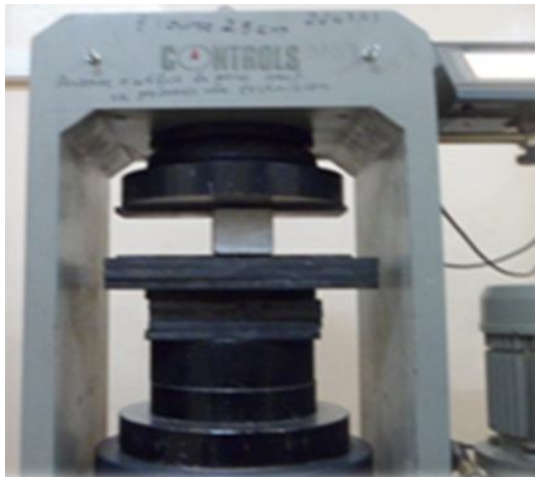


Fig. 5. Compressive strength test

V. RESULTS AND DISCUSSION

A. Fresh state of concrete

From the results presented in Table 6, it was found that all self-compacting concretes comply with the self-acceleration criteria recommended for AFGC recommendations [8].

Table 6: Values recommended for testing [AFGC, 2008]

	SCC40	**SCC45**	**SCC50**	**SCC55**
t50 (s)	2,00	2,65	3,00	3,24
Slump flow (cm)	75	73	68	63
L-box test	0.88	0.86	0.85	0.83
Stability in sieve (%)	10,38	9,48	8,24	6,31

For all SCCs, the halo of laitance at the periphery of

the concrete slabs was absent or very weak (from 1 to 2 mm). In addition, coarse aggregates have always been properly entrained by the cement matrix and have not remained piled up in the middle of concrete slabs. The measured time to reach a slab 50 cm in diameter (t50) is three seconds (3s). This value is close to the values commonly encountered in the bibliography, indeed, Poulson (2002) suggests that this value is from 2 to 5 seconds. While, the time most marked by the fine-siliceous concrete is related to the fineness of additions and its high demand for water [3-5].

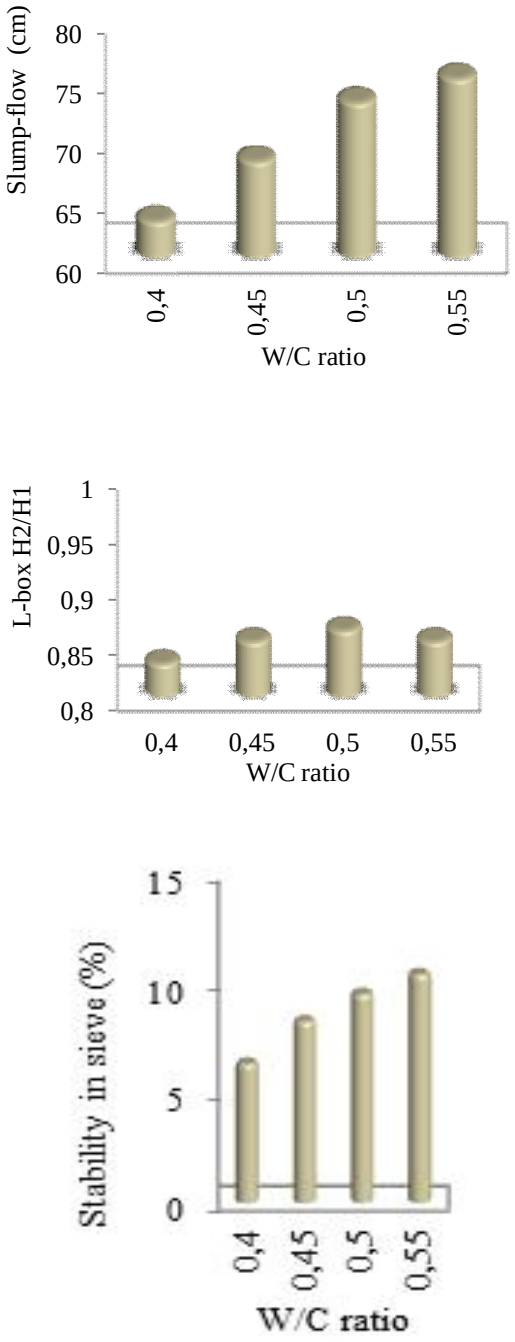


Fig. 6. Workability of SCC

Fig. 6 presents the workability results of the different formula. The quality of fresh concrete was verified because all concretes have an acceptable fluidity according to tests recommended by the AFGC (Slump-flow 63-75 cm). It can show that these concretes have a good mobility in the confined milieu (L-box H2/H1 0.83-0.88). Theses concretes present a good stability (Stability in sieve 6.3-10.4%: do not present segregation).

B. Compressive strength

The mechanical strength is an essential characteristic for the material concrete and one of the fundamental parameters of our study. Consequently, the evolution of compressive strength in time was followed for the various compositions of concrete and the results so obtained are represented graphically in fig 7.

It can be noted from Fig. 7 that the increase in the W/C ratio has resulted in a decrease in the compressive strength. This confirms the negative influence of water on the resistance of concrete

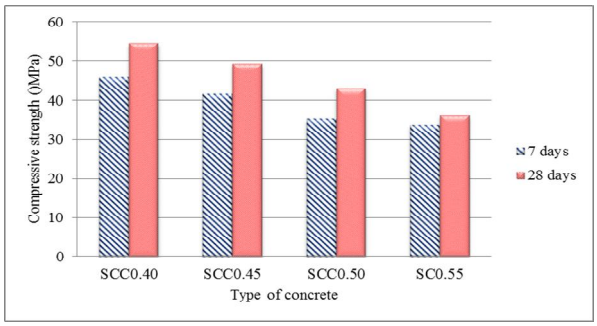


Fig. 7. Compressive strength of SCC

CONCLUSION

The requirements to be met by a SCC compared to other concretes are significantly higher especially with regard to the quantity of concrete components. Through this research, we have demonstrated that it is possible to manufacture SCCs of different composition parameters, having good rheological and mechanical characteristics.

The use of crushed dune sand in the composition of SCC by varying the W / C ratio contributes to a slight variation of the fresh workability parameters while still remaining in the SCC range required by the AFGC 2008 recommendations for these concretes.

The mechanical behavior of the SCC is inversely proportional with the W/C ratio, the mechanical resistances of the SCC have increased with the decrease of W/C racio (resistances reach interesting values, 55 MPa at compression for a ratio (W / C = 0.4).

Finally, we can conclude that our results provide evidence mechanical performance for dune sand development prospects in the new concrete, namely the SCC.

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